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War-related excess mortality in The Netherlands, 1944–45: New estimates of famine- and non-famine-related deaths from national death records

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ABSTRACT

Despite there being several estimates for famine-related deaths in the west of The Netherlands during the last stage of World War II, no such information exists for war-related excess mortality among the civilian population from other areas of the country. Previously unavailable data files from Statistics Netherlands allow researchers to estimate the number of war-related excess deaths during the last stage of the war in the whole country. This study uses a seasonal-adjusted mortality model combined with a difference-in-difference approach to estimate the number of excess deaths in the period between January 1944 and July 1945 at a total of close to 91,000 (75%) excess deaths. Almost half of all war-related excess mortality during the last year of the war occurred outside the west.

KEYWORDS



Excess mortality; famine; estimation; World War II; The Netherlands

Introduction

Throughout history, famine and armed conflict have often conjoined to result in large numbers of casualties. War seriously compromised food entitlements and contributed to severe hunger during, for instance, the English Civil War in 1648 and the French crisis of 1709–10 (Tilly 1983). Twentieth-century famines in particular were often linked to wars and ideology (Ó Gráda 2009). The Great Ukrainian famine of 1933, for instance, was caused by the forced collectivization of the Soviet Union government (Davies and Wheatcroft 2010). Also, during the Second World War, there were several severe famines, like the ones during the Siege of Leningrad (Barber and Dzeniskevich 2005), the occupation of Greece (Hionidou 2006), the Bengal famine (Sen 1981, 52–85), and the Dutch Hunger Winter (Barnouw 1999). More recent armed conflicts like in Sudan in 2003–4 and in Somalia in 2011–12 caused severe famines as well (De Waal 2015, 25–26). Estimating war-related famine and non-famine mortality in a consistent manner will help us to understand trends in warfare across time or space (Lacina and Gleditsch 2006), and long-term consequences for the demographic structure of the populations at risk (see examples in Brunborg, Tabeau, and Urdal 2006). It also contributes to research on long-term health consequences of (early life) exposure to war (e.g.,

Kesternich et al. 2012) and malnutrition (Lumey and Vaiserman 2013), and can also be helpful in conflict resolving and legal proceedings in cases of war crimes and crimes against humanity (see examples in Brunborg et al. 2006; Tabeau 2009).

The Second World War caused an enormous number of deaths, both in terms of military and civilian victims. Gregory Frumkin (1951) estimated the number of deaths in European countries occupied by Nazi Germany at almost 10 million, of which 44% were Jewish victims, and 43% were other civilian victims. In The Netherlands, occupied from May 1940 until May 1945, particularly the last two years of the Second World War had a tremendous impact on mortality. Compared to 1939, life expectancy in 1944 decreased from 68.6 years to 63.6 years in women and from 66.9 years to 59.0 years in men. It further decreased to 61.0 years in women and 50.6 years in men in 1945 (Lumey and Van Poppel 1994). The estimated decreases for 1944 and 1945 are conservative, as not all war-related deaths could be taken into account in calculating life expectancy. The national death statistics, for example, do not include individuals who were formally removed from the local population registers on deportation to Germany and died abroad; approximately 104,000 Jewish citizens who were deported to Germany and Poland; 18,000 political prisoners who were deported to Germany; 27,000 of

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those who were forced to work in Germany; and 7,500 persons missing in Germany and presumably dead. These individuals are missing from the national death statistics as they could no longer be reported by local authorities. This could have resulted in an underestimation by about 25% in the mortality of males aged 20–60 years between 1941 and 1945 (Centraal Bureau voor de Statistiek 1948b; Garssen and Harts 2008; Harts and Broekhuis 2007).

The Dutch Hunger Winter

For decades, two events were central to the Dutch collective memory of human losses due to the German occupation during the Second World War: the persecution and murder of the Jewish population, and the Hunger Winter preceding the liberation. The Dutch famine resulted from a railway strike called by the Dutch government in exile and an embargo on the transport of food supplies imposed by the German occupying forces in early October 1944 as a reprisal for a wave of partisan activity including the railway strike. Whereas before the embargo, the food situation in The Netherlands was generally satisfactory (Trienekens 2000), official food rations dropped sharply thereafter and reached a low of 500 kcal per day by April 1945 in the large cities in the western Netherlands. The famine ceased after the German surrender in May 1945 when Allied food supplies were rapidly distributed across the country. The severity and widespread nature of the famine have been fully documented (Burger, Drummond, and Sandstead 1948).

Although the famine was limited to the urban, western part of The Netherlands, it became a predominating aspect of the representation of the war for the country as a whole. That the famine was not a countrywide shared experience became very clear in 1994 when the southern provinces celebrated the fiftieth anniversary of their liberation (Barnouw 1999). It was not the memories of the deprivation and starvation experienced during the Hunger Winter of 1944–5 that stood central here, but rather the heavy fighting, the destruction, and the many civilians that were victims of the liberation. Whereas the story of the Hunger Winter and its effects have been the topic of numerous books and articles and of heated discussions, the non-famine excess mortality in the non-western provinces in the last months of the war have hardly received attention. Loe de Jong (1980) mentioned the most important more-or-less incidental events which took the lives of many people outside the Hunger Winter area: the bombings in Eindhoven, Venlo, Nijmegen, Westkapelle, and Sluis; the fighting around Oosterbeek; the blowing up of the town hall in Heusden; and the firing of transports in Limburg. In recent years, various studies have been published which examined in more detail the effects of these tragic actions.

They mostly had a strong local focus (Janssen 2005; Rosendaal 2009) or studied a specific war-related activity, such as the effects of the air raids of the allied forces (Korthals Altes 1984). De Jong (1980, 528) estimated the number of deaths in the heaviest affected areas outside the west at more than 3,600.

Whereas a lot of specific estimates have been made for famine-related deaths, with current estimates varying between 15,000 and 25,000 (De Jong 1980; Klemann 2002; NIOD 2012; Trienekens 1985), no such information has been given for excess mortality during the period from September 1944 to May 1945 in the areas affected by actual warfare. A more encompassing estimate of the effects of the war outside the famine areas is thus still lacking. This partly has to do with the absence of reliable and detailed information on mortality in the period concerned. The same factor is at the basis of much discussion on the Hunger Winter's effects. It is a severe limitation of the statistical information on mortality during the years 1944 and 1945 that it is based on aggregated yearly figures at the national level, ignoring that the events leading to excess mortality were concentrated in specific areas and specific months in 1944–5. For famine-related mortality, estimates have also been made by comparisons of excess deaths in some of the exposed municipalities or regions in relation to non-famine years or regions (Boerema 1947; Burger et al. 1948; Dols and Van Arcken 1946b). Using wider time windows, annual numbers of deaths by gender and cause of death at the national level (Centraal Bureau voor de Statistiek 1957) have also been used to study famine-related mortality, although the findings and the appropriate analysis of such data are open to discussion (Futselaar 2008; Lumey 2010). These aggregated yearly figures at the national level might lead to an underestimation of adverse outcomes in specific affected regions and exposure periods. These limitations can now partly be overcome with digitized data files from the Dutch National Central Bureau of Statistics (Statistics Netherlands) that provide information on deaths by detailed causes of death, by calendar month of death, for men and women, and for selected age groups, as well as for specific regions during the war period. The data files include all reported deaths in The Netherlands of people being part of a municipal population register in that time period.

Previous estimates of war-related deaths in The Netherlands in 1944–5

Dols and Van Arcken: 16,000

In 1946, Matthieu Dols and Daan van Arcken (1946a, 1946b) presented the first estimates of the numbers of

deaths due to famine and war in The Netherlands. They calculated the ratios between the total numbers of death in the first six months of 1945 with those in the same period in 1944 for 12 large and smaller cities in the western part of the country.^{1,2} It turned out that in the first six months of 1945, the total number of deaths had been doubled. Remarkably, some of the smaller cities such as Voorburg and Rijswijk did worse than Amsterdam and Leiden. Excess mortality ratios were higher among men than among women, but this was not the case among children younger than 1 year old and in the age group 1–4 years old.

Banning: 10,000

Cornelis Banning (1946) compared crude death rates for the cities of The Hague, Rotterdam, Amsterdam, and Utrecht for the first six months of 1939, 1944, and 1945. Death rates in 1945 were more than double the rates in 1944, in particular in The Hague. Banning estimated 10,000 obvious cases of death by malnutrition. Based on the experiences of Amsterdam and The Hague, it turned out that the vast majority of deaths due to malnutrition were men and that among elderly people much higher percentages of hunger deaths were observed. Banning stressed the fact that the number of people for whom malnutrition was officially reported as cause of death was probably smaller than the number for whom the poor food situation, together with cold and other privations, weakened their resistance so much that their illness proved fatal (Banning 1946, 1947).

Burger: > 10,000

In 1948, Georg Burger and colleagues presented weekly data on the total numbers of deaths for Amsterdam, Rotterdam, and The Hague for the first half of 1944 and 1945. Their conclusion was that even during the most critical period, the nutritional conditions of infants remained relatively good, there being sufficient food for their minimum sustenance. Infants starved only in those cases where “parents were asocial and sold the coupons of the infants.” The greatest difficulties were caused by lack of heating, clothing, and soap.

Central Bureau of Statistics: 16,000

In 1948, the Dutch Central Bureau of Statistics (CBS) published an estimate of the total number of war victims in which they distinguished between direct and indirect victims (Centraal Bureau voor de Statistiek 1948c). Although part of this excess mortality was due to extreme climatological conditions, most of it was caused by the war situation:

worse and lesser quality of food, evacuations, lesser hygiene, and so forth. Whereas the number of direct war victims was estimated at 210,000, the number of indirect victims was estimated at around 70,000. The number of casualties as a direct consequence of the famine in the western part of The Netherlands was estimated at 16,000.

De Jong: 22,000

The discussion about the impact of the famine on mortality was reopened 30 years later following the publication of the standard history of World War II in The Netherlands by De Jong (1981). He emphasized that the famine was restricted to the provinces Noord-Holland, Zuid-Holland, and Utrecht, and only affected the urban population from January 1945 on. It was the population in the cities that was almost completely dependent on a well-functioning distribution system, and it was precisely the distribution system that was dysfunctional. In the countryside, even in the west, sufficient food was produced (De Jong 1981, 192). In the provinces Gelderland, Overijssel, Drenthe, Groningen, and Friesland, there was no real starvation, although part of the urban population was in serious trouble (De Jong 1981, 167). As far as the total number of direct victims of the Hunger Winter in the west was concerned, De Jong stuck to the estimate that Banning had published in 1947: “ten thousand clear cases of death due to undernutrition.” De Jong also made an estimate of the indirect excess mortality: people that died as an indirect consequence of food scarcity because their resistance had decreased. De Jong arrived at an estimate of around 22,000 excess deaths (1981, 277). A summary of historical estimates of excess deaths in this period is given in Table 1.

Trienekens: 16,000

A critical study of the effects of the food shortage on health and mortality was published by Gerard

Table 1. Historical estimates of famine-related excess deaths in The Netherlands in 1945, by year of publication.

Author(s)	Year	Estimate
Dols and Van Arcken	1946	16,000
Banning	1946	10,000
Burger et al.	1948	> 10,000
CBS	1948	16,000
De Jong	1980	10,000 direct and 12,000 indirect
Trienekens	1985	16,000
Barnouw	1999	> 16,000
Klemann	2002	Several tens of thousands
Futselaar	2002	~65,000 directly or indirectly related to hunger
NIOD	2012	25,000

Trienekens (1985). He stressed that the increase in death rates was not only a consequence of the inadequate food supply but also of the filthiness (due to the lack of soap), psychological stress, contamination of food, increasing contacts with the outside world (related to the mobilization, evacuation, standing in queues), and heightened housing density (rationing of fuel), poor medical care (shortages of hospital beds and medicines), defective clothing and footwear, and heightened consumption of human energy. As a consequence, mortality rates had already started to increase in the period 1938–44 before the food situation had deteriorated. Crude cause-specific death rates therefore increased in 1944 “in the densely populated provinces in the west of The Netherlands as well as in those areas where without doubt there was no lack of food” (Trienekens 1985, 389–96). Trienekens (1985, 400–1) used information for the city of Amsterdam to estimate the effect of food shortages on public health. Though the Amsterdam death rates in 1945 compared favorably to those of the other large cities, Trienekens saw no reason to assume that the mortality pattern here was any different from that in other places in the west. In Amsterdam, almost half the total excess mortality in 1945 compared to 1944 was caused by hunger and/or cold. The male population ran higher risks than females, and death rates had increased more among infants and the elderly than in other age groups. Following Dols and Van Arcken, Trienekens estimated excess mortality in the first half of 1945 in the cities in the western Netherlands at 16,000. About half of the excess number had died from hunger and/or cold.

Barnouw: > 16,000

David Barnouw (1999) stressed the combined effect of extreme cold and wet weather with hunger in the winter of 1944–5.³ In his view, the estimate of 16,000 deaths as a consequence of the hunger period must be considered the absolute minimum, as outside the urban west and before and after the first five months of 1945 (the last months of 1944 and even after the Liberation), people also had died of hunger. In line with this, Hein Klemann (2002) argued that hunger, cold, lack of hygiene, and the undermining of resistance in the earlier period of the occupation had each contributed to the increased mortality in the Hunger Winter. The effects of cold took on dramatic proportions in the perception of the population because of the breakdown of the electricity supply, the shutting off of gas, and the decreased supply of coal, whereas at the same time, food shortages strengthened the need for warmth. Klemann (2002, 467–76) concluded that the Hunger Winter “took the lives of several tens of thousands of people.”

Futselaar: 65,000

A different approach to estimate excess mortality was followed by Ralf Futselaar (2006, 195–6). He argued that one problem in estimating excess mortality was the lack of a standard with which to compare mortality in 1944 and 1945 because it is not known how many deaths there would have been in the absence of the German occupation. Futselaar tried to solve this problem by comparing observed numbers of deaths with expected normal values, based on the development of death rates during the late 1930s and early 1940s. Futselaar focused on deaths caused by infectious diseases, as he considered these as the driving force behind much of the upsurge in mortality. Only during the last war years, and only in the age groups older than 15, did violent and hunger-related mortality take over. In a later study, Futselaar (2008) estimated the total excess civilian mortality as a result of the war at 160,000, of whom some 65,000 died during 1945. He claimed most of these cases as being either directly or indirectly related to the famine. The difference with the figure from the NIOD Institute for War, Holocaust and Genocide Studies (NIOD 2012) stemmed from the fact that NIOD did not take into account the changed age structure of the population nor the general downward trend of the mortality rates (Futselaar 2008, 61–2). The famine had in absolute terms the strongest effect on infants and the elderly, but in relative terms, the most affected age groups were middle-aged males.

Klemann: Hundreds of thousands

Futselaar’s study provided the basis for a recent estimate by Klemann of the total excess mortality among youngsters in The Netherlands during the war. “According to Ralf Futselaar, hundreds of thousands of war victims have been ignored because hardly anybody noticed that in a specific age group—say, children and adolescents between 2 and 16 years old—mortality rates, which had been decreasing since the late nineteenth century and again after the war, increased during the Nazi occupation” (Klemann and Kudryashov 2012, 391).

From these sources above, it will be clear that data limitations so far have hindered a balanced view of the loss of human lives during the last two years of the Second World War in The Netherlands. With previously published data on deaths in 1944 and 1945, it has not been possible to compare deaths in hunger-stricken areas and in areas not affected by famine, or to identify with any precision the period of excess mortality in specific regions of interest. For well-defined municipalities, specific information on deaths by sex, age, and cause of death is often very limited. A further problem is that

without information about specific populations at risk, it is not possible to estimate the impact of the war in these groups compared to normal times.

Unresolved questions

In this study, we address some important but unresolved questions about the number of excess deaths related to the liberation and the famine, for specific causes of death. Specifically, we will use new data sources with regional monthly mortality data to address the following questions:

- Considering the period 1944–7, what mortality changes do we see in regions affected by the famine and in other regions that suffered from war-related activities during the liberation of the country?
- What patterns emerge in men and women, in specific age groups, or for specific causes of deaths?

We will study these questions by comparing mortality data in different regions in the country, including the largest cities in the west; the smaller cities and rural areas in the west; and the remaining parts of the country, including the north, east, and south, not exposed to the famine but sometimes strongly affected by military actions.

Data and methods

National cause of death registry

The current analyses are based on the cause of death registry (*Doodsoorzakenstatistiek*) from the CBS, an electronic database that includes registered deaths in The Netherlands from January 1936 to the current date. Entries into the database are from the personal card (*Persoonskaart*) that is held for each resident of The Netherlands in the local population register. The card follows the individual to new locations in the event of change of residence. Deaths in The Netherlands are reported to the local authorities who will, upon completion of a death certificate, forward information from this individual's card to CBS, including place and date of birth, city of residence, and a tracking number to later identify cause of death as determined by the physician completing the death certificate (Thomas 1938; Van Sonsbeek 2005). Deaths among individuals removed from local population registers are not included in the national death registry. Especially in the last years of the war, cause of death information was not always recorded on the death certificate for several reasons. Individuals in hiding might not always be able to seek medical attention

in the case of illness, even when serious, for fear of discovery. The medical confirmation of death could not always take place, and burials were held clandestinely (Boerema 1947, 10). During the war, doctors' tasks were more arduous, doctors were scarcer than before the war, visits to the sick and deceased were more difficult due to the lack of transport, and many ran the risk of arrest. Due to all of this, information on the death certificate (in particular the cause of death) was often incomplete.

As set out above, the CBS database includes individual death records with information on date of death, age at death, sex, cause of death, place of death, and place of residence. Current and past CBS publications on causes of death in selected periods and regions are all based on these data and have been used previously for studies of famine and mortality. We have used these data for a series of analyses that have not been undertaken before. Our analyses will focus on four questions.

First, we evaluate war-related mortality across the entire country, in contrast to earlier studies which only included the three largest cities or a selected group of 12 urban municipalities for famine-related mortality. Second, we compare mortality between regions with severe famine exposure in the urban west and regions elsewhere with no or moderate famine exposure. We also compare the mortality impact of military activities in different regions during the liberation of the country. Third, we trace changes in mortality over time for selected causes of death in selected regions and age groups among both men and women, allowing for more precise estimates of the effect of famine and military activities. Fourth, we calculate age-specific death rates to show the impact of the famine and of the war-related events both in absolute and in relative terms.

Up to 1950, CBS used the Dutch version of the fifth revision of the International Classification of Diseases (1938) to classify causes of death by over 200 categories (International Commission for the Decennial Revision of Nosological Nomenclature 1940). We aggregated these categories into the 17 main causes of death provided by the ninth revision of the International Classification of Diseases (1975) and concentrated on eight clusters: deaths from diseases of the circulatory, respiratory, and digestive systems; neoplasms; infective and parasitic diseases; ill-defined conditions; other causes; and deaths from external causes. The latter group was further divided into deaths from malnutrition, cold, deaths during military service in The Netherlands or Germany, war-related civilian casualties, and executions. To meet CBS privacy requirements, disease and other categories were selected to ensure adequate numbers for each level of cross-classification. Age at death was classified into the categories 0, 1–14, 15–24, 25–54, 55–69, and 70+

years to compare the impact of famine and other war events over time in different age groups.

Monthly data

Deaths were analyzed by month. For the years 1944 and 1945, deaths were only available for this time window. Monthly data are detailed enough, however, to show relevant changes in data patterns with optimal accuracy. To facilitate comparisons with previous work on the famine (Stein et al. 1975), we distinguished three regions for the analysis of deaths over time in the period 1944–7: first, the six large cities of the western Netherlands: Amsterdam, Rotterdam, The Hague, Leiden, Haarlem, and Utrecht (Urban West), which were particularly affected by the famine; second, the smaller cities and rural areas of the western provinces, including all other municipalities in the provinces Noord-Holland, Zuid-Holland, and

Utrecht (Rural West); third, the remainder of The Netherlands (Rest Netherlands). See Figure 1.

We compared monthly changes in overall and cause-specific death rates in age-, sex-, and region-specific subgroups, calculating the number of deaths per 1,000 (average) population in each specific subgroup. Although age- and sex-specific population counts for all municipalities are available for the census years 1930 and 1947, information specifically for the years 1944–6 is missing for most municipalities in The Netherlands (Centraal Bureau voor de Statistiek 1948a). This is because during the war period, the record (*Persoonskaart*) of a significant number of individuals who had left their municipality because of deportations, imprisonment, evacuations, or hidings (or relocations for other reasons) was most likely not immediately removed from the local population register (CBS 1947).

We therefore estimated the population at risk for the selected age and sex groups in selected time



Figure 1. Map of The Netherlands, March 1945. Frontline adapted from Ben Schoenmaker (1995, 289).

periods and regions by adding relevant information from other sources, including estimates of the total population of The Netherlands by age (year of birth) and sex on January 1, 1944–8 (Centraal Bureau voor de Statistiek 1970); population counts by sex and region (urban west, rural west, rest Netherlands) on January 1 in 1944–8 from the *Demografische databank Nederlandse gemeenten* (Demographic database Dutch municipalities; Beekink and Van Crujning 1995); and population counts as per May 31, 1947 from the national census by year of birth, sex, and region.⁴ We considered the monthly population at risk in a specific year to be the average population (for each sex and age group in each region) between January 1 and December 31 of that year.

We used the years 1946 and 1947 as the reference period to compare changes in mortality in the years 1944 and 1945 relative to more normal circumstances. Monthly mortality patterns were calculated as deviations from the reference, taking seasonal mortality fluctuations into account.

Excess mortality estimation

Estimates of excess mortality in 1944–5 in relation to famine and war-related events are based on two steps:

- (1) Estimate the number of deaths per month (by region, sex, and cause of death) in the absence of the event (i.e., under normal circumstances), and
- (2) Subtract this estimate from the observed number of deaths in the presence of the event.

The baseline mortality level is estimated by applying a linear model to the monthly death rates, k_{irt} , in 1946 and 1947⁵:

$$k_{irt} = \beta_{ir0} + \beta_{ir1} \cos\left(\frac{\pi t}{6}\right) + \beta_{ir2} \sin\left(\frac{\pi t}{6}\right) + \varepsilon_{irt}$$

with i as the selected cause of death, r as the region (urban west, rural west, or rest of The Netherlands), and t as the month number since December 1943. The model contains seasonal adjustments by sinus and cosine functions (Lui and Kendall 1987). The observation period is too short to include a trend parameter like in similar models used for estimating seasonal mortality patterns over long time periods (Eilers et al. 2008; Ekamper et al. 2009).

The estimation is carried out separately for each of the two sexes, age groups, and regions. Based on these estimations, we obtain predicted sex-, age-, and region-specific death rates for each month of 1944 and 1945, \widehat{k}_{irt} , and subtract these from the observed death rate to obtain the

excess death rate:

$$e_{irt} = k_{irt} - \widehat{k}_{irt}$$

As the next step, we calculated for each month in the years 1944–5 a difference-in-difference (DiD) of the excess death rates (Cameron and Trivedi 2005). This value reflects the difference between the excess death rate in a given month in the years 1944–5 in a particular region, e_{iFt} , and the excess death rate in that same month in another region e_{irt} :

$$d_{it}^r = e_{iFt} - e_{irt}.$$

This DiD filters out excess deaths associated with regions unaffected by the studied events and corrects for changes in deaths over time that affected all regions. DiD excess death ratios can be transformed to actual numbers of excess deaths by multiplying with the relevant age-specific populations.

We used the standard error of the predictions to calculate the 95% confidence intervals around the excess death ratios and to derive standard errors for the DiD estimates. A modification of these procedures was used for causes of death that only occurred during the war period and not in 1946–7.

The use of the cause of death statistics has some limitations. Although the overall mortality patterns appear to be reasonable, a more detailed analysis at the municipal level revealed some local inconsistencies. Destruction (by sabotage) or damage to municipal population registers, disorganization of the administrative system, and the severing of contacts with the liberated areas could lead, for instance, to backlogs in the central reporting of deaths. In some municipalities, particularly in the frontline area around Arnhem where the Allied Market Garden operation took place in September 1944, we indeed observed a backlog of war-related deaths. These deaths were registered as having occurred several months after the war had ended. Since the number of incorrectly timed deaths was limited to a few hundred, trends at the national or even regional level will hardly be affected by this misclassification.

Results

Monthly patterns

Figure 2 shows monthly deaths combining all causes (rates per 1,000 population) for the years 1944–7 in The Netherlands, by sex, in the locations of interest. We here distinguish the cities and rural areas in the western part of The Netherlands and the remainder of the country. There is a seasonal pattern, but more important to note first is the

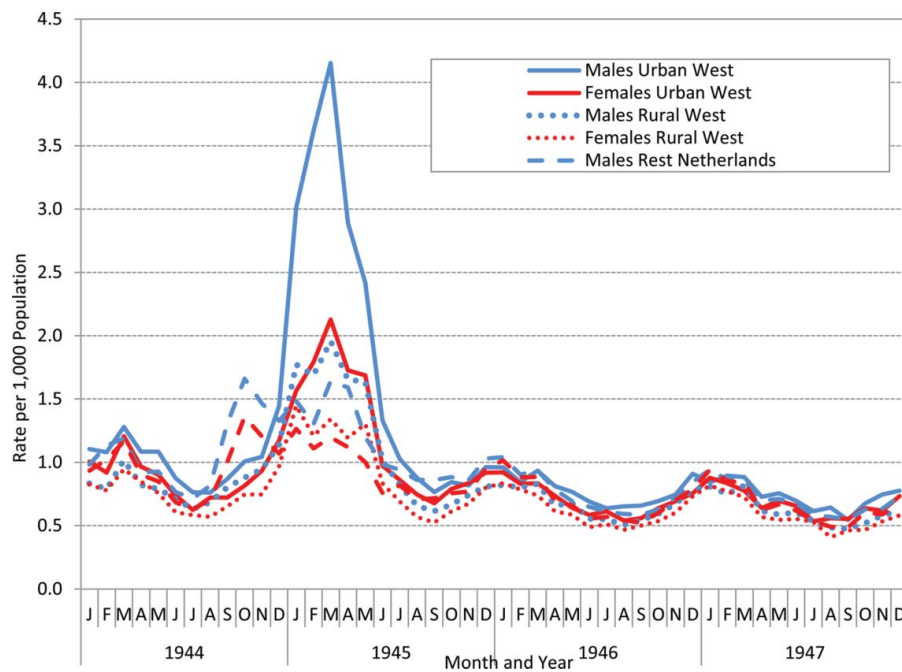


Figure 2. Deaths per 1,000 of the population, by region, sex, and year and month of death, in The Netherlands, 1944–7. *Source:* Calculations by NIDI using non-public microdata from Statistics Netherlands.

increase in mortality among both men and women during the last four months of 1944 in the non-western Netherlands. As will be shown later, these were mainly civilian deaths due to wartime operations and deaths from unknown but war-related causes. We know they were mostly located in the southern provinces during the liberation of the country and around the Arnhem area during the failed Operation Market Garden. Then, starting in December 1944, we see a rise in deaths in the western cities at an ever-increasing rate, reaching their highest levels in March 1945. This trend was particularly strong among men. Increases were also seen in the rural west but to a much smaller extent. In this period, mortality among women in the western cities was about as high as mortality among men in the rural west.

Causes of death

Table 2 provides an overview of reported deaths in The Netherlands over the years 1944–7, classified by disease category. In the last year of the war, nearly a fifth of all individuals died from external causes of death (“injury and poisoning”), and in that year their relative impact was as strong as deaths from conditions of the circulatory system (i.e., heart disease) and twice as important as deaths from cancer. In 1945, there was also a marked increase in deaths from unknown causes (“ill-defined conditions”). Throughout the war, deaths from infections or parasitic conditions were more common than after the war. Through this, the relative importance of deaths from

diseases of the circulatory system and from neoplasms (cancers) changed considerably in these years. These two conditions together accounted for almost half of all deaths in 1947, but only for a quarter of deaths in 1945.

Age-specific monthly patterns

Figures 3a–3f show the death rates broken down by age group and sex.⁶ In relative terms, similar changes were seen across all age groups. In absolute terms, however, the age groups most affected were the youngest infants between 0–1 year, the older men and women between 55–69 years, and especially those aged ≥ 70 years. At all ages, men were more affected than women.

In the age group 0–1 year (Figure 3a), males in the urban west show the strongest increase, starting in the beginning of 1945 and peaking in March–May 1945. After liberation in May 1945, the rates rapidly returned to their prewar levels.

Death rates in the age groups 1–14 years and 15–24 years (Figures 3b and 3c) were the lowest overall. Nevertheless, the regional differences are very clear, and first show an early rise in rates in the autumn of 1944 among both sexes outside the west and then a rise in the western cities starting in early 1945. Death rates for the ages 25–54 years (Figure 3d) were also relatively low, and again show early rises for men and women in the fall of 1944 and later rises in early 1945, especially for men in the western cities. Most men in this age group were “disappeared,” due to forced labor in Germany or in hiding.

Table 2. Causes of death (in percentages) in 1944–7 in The Netherlands, by ICD9* or ICD5** classification.

ICD9	ICD5	Cause of death	1944	1945	1946	1947	1944–7
VII	90–103	Diseases of the circulatory system	21.4	18.4	27.3	31.2	23.4
II	45–57	Neoplasms	12.9	9.5	16.7	17.7	13.4
VIII	104–14	Diseases of the respiratory system	9.4	6.7	9.3	8.1	8.2
XVII	162b, 199–200	Symptoms, signs, and ill-defined conditions	9.9	15.6	7.3	8.0	11.0
I	44	Infective and parasitic diseases	11.9	11.8	10.9	7.2	10.8
XVI	77–9,163–98	External causes of injury and poisoning	14.8	18.0	5.5	5.3	12.3
IX	115–29	Diseases of the digestive system	5.0	7.5	4.7	4.9	5.8
XV	158–61	Certain conditions originating in the perinatal period	3.3	2.9	4.9	4.5	3.7
X	130–9	Diseases of the genitor-urinary system	3.4	2.9	4.2	4.3	3.6
XIV	157	Congenital anomalies	1.4	1.3	2.6	2.3	1.7
VI	80–3,85–9	Diseases of the nervous system and sense organs	2.0	1.6	2.1	2.1	1.9
V	84, 162a	Mental disorders	1.4	1.1	1.1	1.5	1.3
III	58–71	Endocrine, nutritional, and metabolic diseases	1.3	1.0	1.4	1.3	1.2
XI	140–50	Complications of pregnancy, childbirth, and the puerperium	0.5	0.3	0.5	0.5	0.4
IV	72–6	Diseases of blood and blood-forming organs, and immunity disorders	0.4	0.4	0.5	0.5	0.4
XIII	154–6	Diseases of the musculoskeletal system and connective tissue	0.6	0.4	0.5	0.4	0.5
XII	151–3	Diseases of the skin and subcutaneous skin	0.6	0.6	0.3	0.3	0.5
Total %			100.0	100.0	100.0	100.0	100.0
Total number of deaths			108,087	141,398	80,151	77,646	407,282

*ICD9: International Statistical Classification of Diseases and Related Health Problems, Revision 9, Main Categories, 1975.

**ICD5: International Lists of Causes of Death, Revision 5, Selected Categories, 1938. Causes of death ordered by frequency of occurrence in 1947.

Source: CBS (1944, 1945).

For the ages 55–69 years (Figure 3e), death rates in 1944–7 range between 2 and 10 per 1,000 population and are about ten times higher in absolute terms compared to the previous age groups. The increase is limited to deaths in early 1945 and is especially pronounced among men in the western cities.

Among the oldest ages (≥ 70 years), overall mortality is higher again, ranging between 10 and 40 per 1,000 population (Figure 3f). A strong seasonal component is seen in this age group, with increased deaths in the winter. The highest death rates were seen for men and women in western cities between December 1944 and May 1945, with a four-fold increase for men and two-fold increase for women compared to the usual pattern. Even men and women in the rural west, however, showed significant increases in this period. By contrast, death rates outside the west of the country in this age group were hardly affected.

Excess mortality

In Figure 4, the estimated excess mortality for men and women of all ages in 1944–5 is shown by month and year in relation to the expected mortality under normal conditions in the western cities, rural areas, and non-western parts of the country. There is an increase in excess deaths from August 1944 onward, starting in the regions outside the west. The increase was most pronounced among men but is also seen among women. We know from other sources that this excess was mainly due to military activities during the liberation of the southern part of the country. From January 1945 onward, there

was enormous excess mortality in the largest cities in the west, in particular among men, with the highest levels in March 1945. The number of excess deaths was also rather high in the rural parts of the west, in particular among males. Excess deaths were also seen for men and women in the non-western part of the country (due to military activities during the liberation of the east and the north of the country).

Figure 5 shows the excess mortality for men and women in 1944–5 by region and cause of death. In all subgroups (except for women in the rural west), the most common deaths in these years were from “external” causes, including injuries and other war-related events. In absolute numbers, these deaths accounted for close to 40% of excess deaths among men in the western cities and for over half of excess deaths outside the west. In the rural west, the patterns were less pronounced. Infective and parasitic diseases were the second most common cause of excess deaths, accounting for 10%–20% of excess mortality, particularly outside the west. In these years, deaths from ill-defined conditions were the third most reported cause of death, indicating wartime stresses on the registration system in all regions. There was no increase in deaths from cancers.

War-related death causes

In Table 3, we show officially reported deaths (by cause of death) from selected conditions that were particularly associated with the wartime situation in 1944–5 (Centraal Bureau voor de Statistiek 1944, 1945). These include over 17,000 deaths in 1944 and about 35,000 in 1945

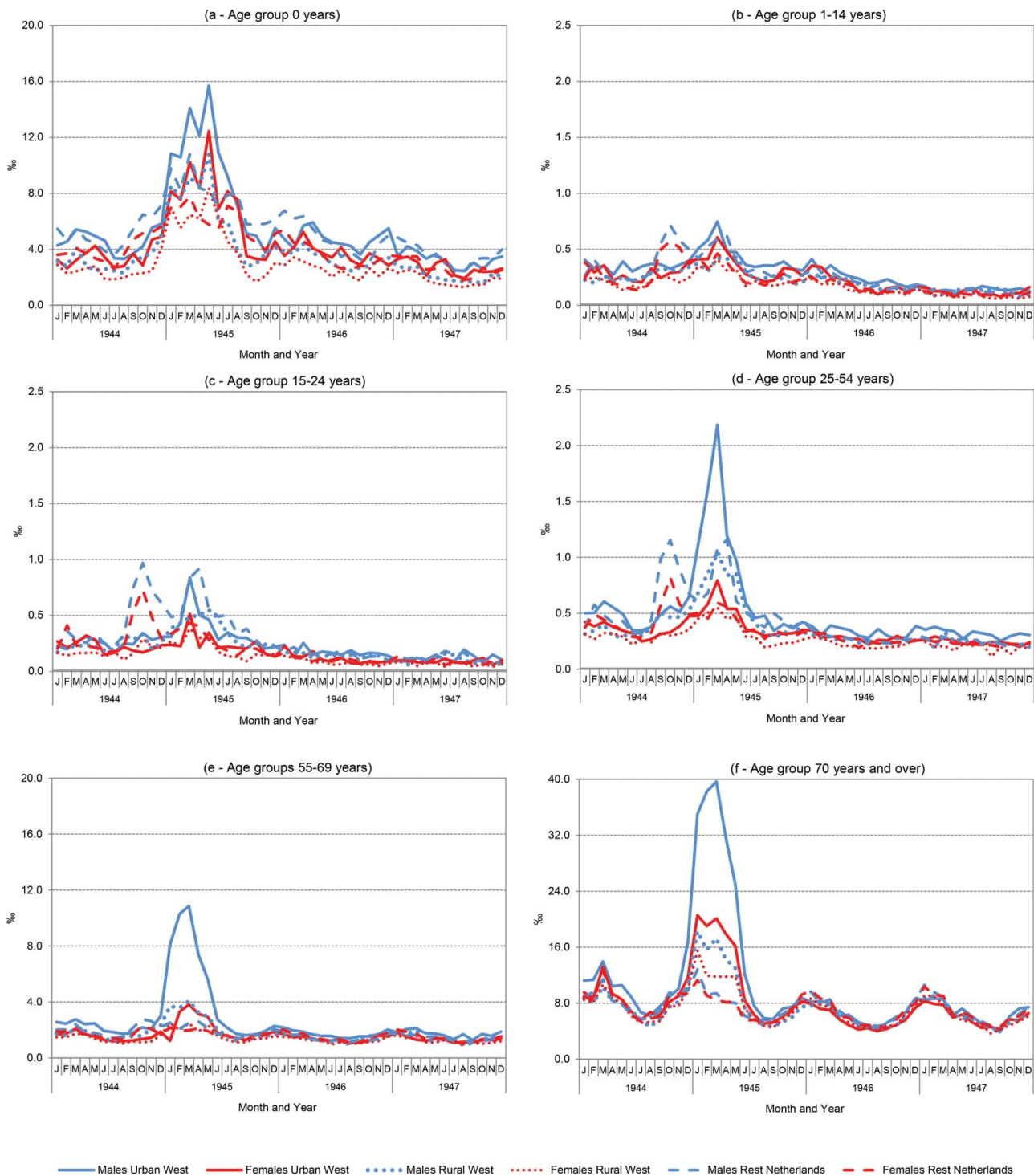


Figure 3. Deaths per 1,000 of the population, by age group, region, sex, and year and month of death, in The Netherlands, 1944–7. (a) age group 0 years; (b) age group 1–14 years; (c) age group 15–24 years; (d) age group 25–54 years; (e) age group 55–69 years; (f) age group ≥ 70 years. *Source:* Calculations by NIDI using non-public microdata from Statistics Netherlands.

from hunger or thirst, cold, war-related conditions, and other selected causes. Of these, over 50% in 1944 were due to civilian deaths in operations of war, and over 40% in 1945 to deaths from unknown or unspecified causes.

Civilian deaths were seen in particular during September and October 1944 and later again in April 1945 from

bombings and casualties outside the west as known from other sources. In 1944–5, 11,445 men and 5,944 women were reported as civilian deaths from the operations of war.

Among the war-related deaths in 1945, one in five was reported as due to hunger. Much smaller numbers were classified as deaths from homicide, in military service, or

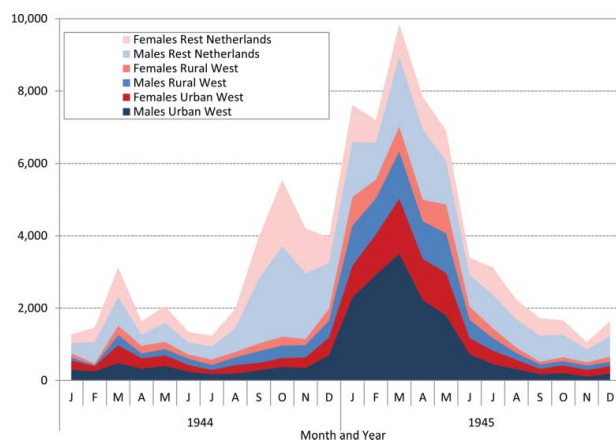
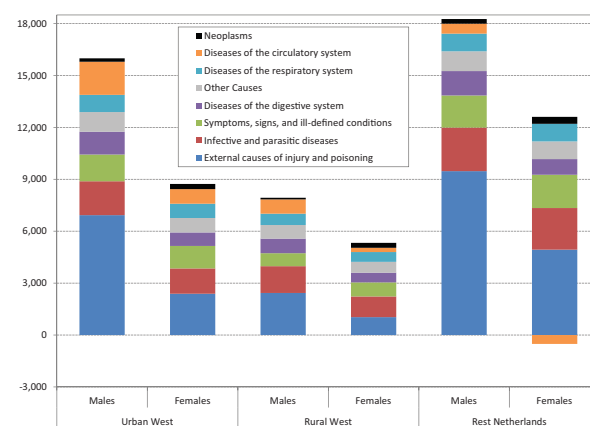


Figure 4. Number of excess deaths by region, sex, and year and month of death, in The Netherlands, 1944–5. Estimated from postwar pattern 1946–7. *Source:* Calculations by NIDI using non-public microdata from Statistics Netherlands.

from legal executions (of mostly men).⁷ The number of reported deaths from cold was very small. Deaths from hunger were first reported in November 1944 in the western cities, but these numbers strongly increased from January 1945 onward and peaked in March 1945. In all regions, male deaths from hunger were three to four times more common than female deaths.

It is remarkable that in June and July 1945, one to two months after liberation, hunger deaths were still being reported, particularly in the western cities. These deaths can be seen as lagged effects of the famine, two months after adequate food supplies had been restored. The number of reported deaths from hunger during the period 1944–5 was 8,305.

In Figures 6a and 6b, we show reported deaths from specific war-related conditions between September 1944



* Estimated from post-war pattern 1946–1947.
Source: Calculations by NIDI using non-public microdata from Statistics Netherlands.

Figure 5. Number of excess deaths by region, sex, and cause of death, in The Netherlands, 1944–5. Estimated from postwar pattern 1946–7. *Source:* Calculations by NIDI using non-public microdata from Statistics Netherlands.

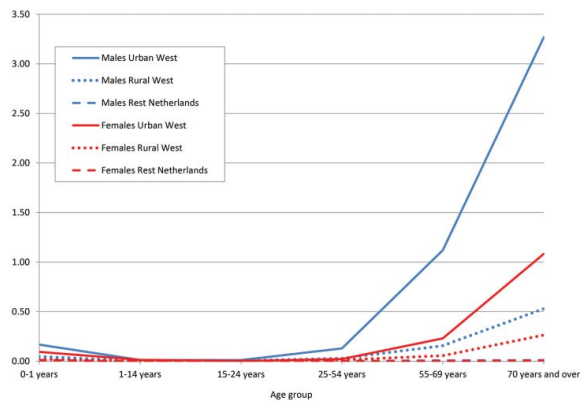
and December 1945, by age at death for men and women in the different regions. We include deaths attributed to hunger (Figure 6a) and deaths attributed to executions and casualties among civilians (Figure 6b).⁸ This observation period was chosen because the impact of the famine (as mentioned above) was still visible after the liberation in May 1945 and because civilian casualties had started to rise as early as in September 1944 in the south. For comparison, the same timeframe was chosen for these distinct causes of death. Figure 6a clearly confirms the extreme differences in hunger deaths by age, sex, and region of death in this period, with the highest rates among the oldest men in the western cities. Around 30% of the excess mortality was from deaths in men and women ≥ 70 years of age and 17% from deaths among

Table 3. Deaths from famine, other war-related causes, and other unspecified causes of death, in The Netherlands, 1944–5 (in percentages).

ICD5*	Cause of death	1944			1945		
		Males	Females	Total	Males	Females	Total
165–8	Homicide	2.2	0.9	1.7	1.7	0.6	1.5
189	Hunger or thirst	0.3	0.5	0.4	22.3	28.8	23.6
190	Excessive cold	0.1	0.2	0.1	0.3	0.6	0.3
196a	Deaths of persons in Dutch military service during operations at war	0.1	0.0	0.1	0.4	0.0	0.3
196b	Deaths of persons in German military service during operations at war	3.9	0.0	2.6	1.6	0.0	1.3
197	Deaths of civilians due to operations of war	53.2	65.3	57.2	19.3	31.2	21.8
198	Legal executions	5.0	0.2	3.4	5.6	0.3	4.5
199	Sudden death	8.2	10.5	8.9	4.3	9.3	5.3
200a	Ill-defined causes	0.9	1.3	1.1	1.5	2.8	1.8
200b	Found dead, cause unknown	0.2	0.3	0.2	0.1	0.1	0.1
200c	Other deaths from unknown or unspecified cause	26.0	20.8	24.3	42.9	26.5	39.4
	Total %	100.0	100.0	100.0	100.0	100.0	100.0
	Total number of deaths	11,510	5,598	17,108	27,525	7,337	34,862

*Cause of death codes from the International list of Causes of Death, Revision 5, 1938 (ICD5).
Source: CBS (1944, 1945).

(a – Hunger)



(b – Executions and civil casualties)

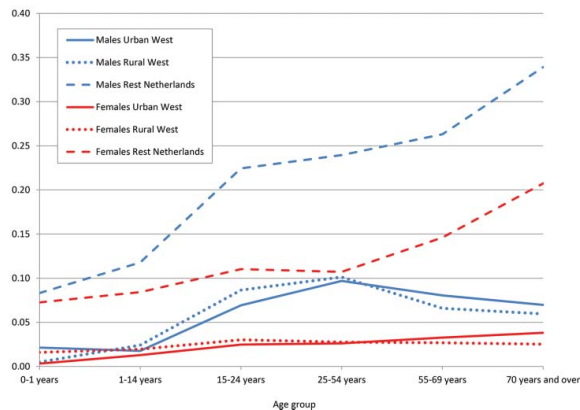


Figure 6. Age-specific death rates due to hunger (a) and executions and civil casualties (b) by region and sex (per 1,000 of the population), in The Netherlands, September 1944–December 1945. *Source:* Calculations by NIDI using non-public microdata from Statistics Netherlands.

men and women aged 55–69 years. Children younger than age 1 contributed to about 10% of excess deaths.

Summary estimates

The total baseline estimate of famine and non-famine excess deaths within The Netherlands between January

1944 and July 1945 depends on the observation period of interest (Table 4). From January 1944–May 1945, the estimated number is just over 68,000. The estimated number for the period January–July 1945 is 45,000. The excess deaths were mostly seen between January and April 1945 among men. One-quarter of excess deaths were seen among men in the cities in the west, another quarter among men in the non-western parts of The Netherlands, and a little over 10% among men in the rural west. Increased mortality among women in the cities contributed around 13% of the deaths.

Discussion

By analyzing information from previously unavailable CBS sources, we were able to overcome several limitations inherent to earlier analyses of mortality in The Netherlands during the last two years of the Second World War. Instead of being limited to the use of aggregated yearly data at the national level or to information from some selected famine-exposed municipalities, we were able to use CBS death records with information on cause of death by calendar month of death, separately for men and women, and for selected age groups. With this information, it was possible to compare mortality patterns over time within and outside the famine regions.

Excess mortality estimates

The first question we addressed is what war-related mortality changes could be seen during the last period of the occupation and the liberation of the country. Previous studies had noticed that even after the liberation, people had still died as a consequence of the extreme circumstances during the War. We therefore estimated excess mortality within The Netherlands over several time periods, including the months from January 1944 to May 1945. In some cases, it would be more relevant to add the months of June and July 1945, and in some cases, it might even be better to start the observation period in September 1944.

Table 4. Estimates of war-related excess deaths* in The Netherlands in selected time periods between January 1944 and July 1945 by region.**

Region	January 1944–July 1945	January 1944–May 1945	September 1944–July 1945	September 1944–May 1945	January–July 1945	January–May 1945
Urban West	26,586	24,728	22,871	21,013	20,238	18,380
Rural West	14,680	13,254	12,427	11,001	10,138	8,712
Rest Netherlands	33,278	30,350	26,497	23,569	14,411	11,483
Total	74,544	68,332	61,795	55,583	44,787	38,575

*Excess deaths estimated as deviations from monthly age-, sex-, and region-specific national mortality data in 1946–7, adjusted for seasonal trends as outlined in the text.

**Excluding 16,400 deaths missing information on region and/or month of death.

Source: Calculations by NIDI using non-public microdata from Statistics Netherlands.

Depending on the period chosen, excess mortality varied between approximately 39,000 and 75,000 deaths (Table 4). If one ignores the excess deaths in 1944 with the enormous death toll outside the western region, our estimates vary between 39,000 and 45,000 deaths. Our baseline estimate for excess deaths is 45,000 between January 1945 and July 1945 (Table 4). These estimates only include excess deaths that could be linked to both region and month of death. Such information is missing for an additional 16,400 deaths (3,200 in 1944 and 13,200 in 1945), and 83% of these deaths were among men in the age group 15–54.

Our estimates of the number of excess deaths in 1945 differ from previous estimates by others for the same period (summarized in Table 1). Dols and Van Arcken (1946a, 1946b) and Trienekens (1985) seemed to estimate a 20%-too-low excess mortality in the western cities in the first half of 1945. With respect to total excess mortality directly or indirectly related to the famine, we consider the estimations of the NIOD Institute for War, Holocaust and Genocide Studies (2012) and Futselaar (2008, 61–62) clearly too high, as our estimates include deaths from all causes, including external causes of death. The assertion by Hein Klemann and Sergei Kudryashov (2012, 391) that hundreds of thousands of war victims have been overlooked to date cannot be substantiated with empirical data.

We estimate that the number of excess deaths in the period January 1944 to July 1945 was about 74,500. Adding to this estimate the 16,400 excess deaths with unknown month or region of death, we arrive at a grand total of close to 91,000 excess deaths in this period.

Sex-, age-, and cause-specific patterns

Previous studies on famine- and crisis-related mortality found differences between males and females, and between age groups. Male mortality often exceeded female mortality, especially for younger adult males, though age-specific differences were less consistent. This female mortality advantage is explained by several factors, ranging from social and political factors (like preferential treatment to women and children) to biological factors (like body fat and immune responses). (See, e.g., Macintyre 2002 and Healey 2015 for extensive summaries of literature; Li and Wen 2005 for men suffering higher mortality than women for post-WWII armed conflicts across time and countries; and Tabeau 2009 for age- and sex-specific mortality in the 1990s armed conflicts in former Yugoslavia).

With regard to our second question on sex- and age-specific patterns and changes over time for specific causes of death, we have the following observations. Men experienced more excess mortality than women at all

times in all regions. These excess deaths were not only due, however, to increased mortality among men in the urban west; men outside the west contributed even more to the excess than males in the urban west. The excess number of deaths among women in the urban west was of the same order of magnitude as the excess for men in the rural west. Excess deaths were disproportionately common among men of 70 years or older, even though the size of this age group was relatively small.

For hunger deaths, Centraal Bureau voor de Statistiek (1944, 1945) reported 8,300 between December 1944 and July 1945. This is smaller than the numbers circulating in the literature. The discrepancy can be explained by the inclusion by most other studies of deaths from other causes, aggravated by malnutrition. This may apply not only to diseases for which food played an important role, including tuberculosis, but also to other conditions. The estimates of Banning (1946, 1947), Centraal Bureau voor de Statistiek (1948b), De Jong (1980, 218–9), and Klemann (2002, 467) are of the same order of magnitude, but as is clear from the above, the attribution of excess deaths to famine alone is likely to remain arbitrary to some extent.

The more specific findings from the literature regarding the age, sex, and time pattern of hunger-related mortality in previous estimations of the Dutch famine and the female mortality advantage were generally confirmed by our study. Famine was indeed largely restricted to the urban west, although in the rural part of the west, the number of deaths reportedly due to hunger was as large as 20% of the number observed in the urban west.

Changes in the monthly death pattern by sex, age, and region clearly bring to light the strong differences between the regions in the evolution of death rates. We were struck by the enormous excess loss of lives from external (non-natural) causes (Figure 5) outside the west. In particular, in 1944 but also in 1945, the excess mortality outside the regions faced with food shortages was much higher than under normal circumstances. The excess deaths were mostly experienced by civilians during bombings and military activities. Furthermore, in the western part of the country, males in the rural west did not fare much better than women in the cities most affected by the famine.

Summary and conclusions

We estimated the total number of war-related excess deaths among civilians in The Netherlands in the period January 1944–July 1945 close to 91,000 (75%). We used a seasonal-adjusted mortality model combined with a DiD approach to estimate age- and sex-specific excess mortality by month for three regions (urban, rural, and

outside west). The most striking result of our analyses is that the actual military fighting activities during the liberation of the non-famine area outside the west of the country was at least as dramatic in its war-related mortality consequences for the civilian population as the famine in the west. Whereas hunger and cold have always been seen as the most important cause of excess mortality during the last year of the war, almost half of all (famine and non-famine) war-related excess mortality in that period occurred outside the famine area. The area outside the west suffered from over 70% of all excess mortality in the period September–December 1944, and still 30% in the period January–May 1945. Excess mortality was higher for men than for women at all times and in all three regions, in line with the female mortality advantage observed in previous studies of the Dutch famine and other famine studies.

The data used for this analysis have some limitations. It is clear that the registration of causes of death during the war, and in particular during the last stages of the war, was much less complete, accurate, and reliable than in normal times. Many more cases during the war were registered with unknown cause of death. The extent of this phenomenon varied from region to region. A further limitation is that for 16,400 deaths, the exact timing and region of death were not known. Neither do the death statistics include individuals who were deported and died abroad (Jewish citizens, political prisoners, those who were forced to work in Germany). These limitations do not, however, distract from the overall pattern described above.

After the war, two contrasting opinions were voiced regarding the possibility to deepen our understanding of the war's effects on mortality. Whereas Marinus Neurdemburg (1947, 392) was optimistic and expressed his curiosity “about what CBS will be able to build from the scraps of the population registration,” Ite Boerema (1947, 13) argued that “quantitative information about the mortality and morbidity of our population in the last year of the war might have statistical relevance, but is completely worthless for a scientific study (...) and would only have political or propagandistic significance.” We think that the new CBS data sources provide an opportunity to significantly add to our knowledge of human losses during the Second World War in The Netherlands both nationwide and at the local level. We expect that it will soon be possible to (1) evaluate (excess) mortality patterns over longer time periods, including the early war years 1940–3 and the prewar period before 1940; (2) examine wartime (excess) mortality patterns at the more detailed spatial level of municipalities; and (3) combine mortality data with newly digitized contemporary news reports to further examine the

impact of specific war-related events. At the individual level, death certificates from individuals who died during the Second World War period will increasingly become available in digitized format and include the occupation of the deceased. With this information, potential changes in the relation between socioeconomic differentials and excess mortality in The Netherlands can be studied across different regions and time periods. We expect that future studies will further integrate this information with currently available data to better understand the scale and the nature of human losses in The Netherlands under German occupation during 1940–5.

Notes

1. Some larger cities such as Utrecht (173,000 inhabitants), Haarlem (150,000), Zaandam (40,000), Velsen (33,000), and Beverwijk (24,000) were not included in their study.
2. Amsterdam, Rotterdam, Den Haag, Rijswijk, Voorburg, Delft, Leiden, Gouda, Schiedam, Vlaardingen, Dordrecht, and Hilversum.
3. The winter of 1944–5 was not extreme in statistical measurement terms. The Dutch national meteorological institute KNMI assigned this winter a Hellman cold index of 83.3, which puts it at the 37th position in the ranking of coldest winters in The Netherlands since 1901. Yet, there was a period (from January 23–30, 1945) with seven ice days (maximum temperature below 0°C) and a lowest temperature of −13.3°C.
4. Data are from unpublished tables of the Volks- en beroepstelling 31 mei 1947, Table 3. Bevolking naar geboortear. Scans are available at http://www.volkstellingen.nl/nl/scans_1947/1947/index.html.
5. Banning (1948) argued that crude death rates in 1946 and 1947 underestimate normal levels as many of the elderly and less robust persons who would normally be expected to have died in 1946 and later died prematurely in the famine period.
6. In comparing Figures 3a–3f, be aware of the different scales of the subfigures due to the large differences in the monthly death rates by age group.
7. We use here the official statistical name for this category of causes of death.
8. In comparing Figures 6a and 6b, be aware of the different scales of the sub figures due to the large differences in death rates by cause of death.

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